REM x-cut Integration Project
- Project Planning Meeting -

Half Moon Bay, CA
Robert Clay
28 July 1999

Sandia National Laboratory

Meeting Objectives

- Make sure we all understand basic structure, vision, and goals of the project
  - » project leadership and program connections
  - » key project elements
  - » who's signed up for what?
- Problem definition and design
  - » focus on requirements from our users (Charlie, Greg, Lee)
  - » need long-term design vision/plan
  - » need short-term prioritized plan to get high-valued deliverables out in FY00

Meeting Agenda

08:30 introductions and agenda review (robert/all)

08:45 opening remarks from REM program (pete dean)

09:00 project overview (robert)

09:30 model manager / meshing framework design

      - review functional requirements (ben)

      - what do designers need? (lee/charlie/greg)

10:15 break

10:30 continue above design discussion

12:00 lunch

Meeting Agenda

12:30 discussion of data abstractions (all)

     - mesh representations (EX-II/DMF)

     - solid model representations

13:30 discussion of core architecture (REM arch group report)

14:00 break

14:30 discussion of viz requirements/plans

15:00 numerical components (alan)

15:30 discuss next steps and action items

16:30 adjourn

REM x-cut Integration Project
- Project Overview -

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Basic questions

- What is the REM x-cut integration project?

- What problem are we solving?

- How are we planning to solve this problem?

- Who's involved, and how?

- What's the current status?

- What's next?

X-cut Integration Project

- REM x-cut focus application serves as a focal point for program and technology integration
  - » B61 laydown is the initial x-cut focus app
  - » other apps being evaluated for follow-on activities
  - » requirements are based on mission critical weapons applications
  - » view problem from soup to nuts (end-to-end, D-to-A, perspective)
  - » prioritize deliverables based on value to customer (designers and weapons codes)

- REM/PSE/DISCOM programs merge to meet strategic needs
  - » integrated project plan (PSE/DISCOM IP) developed
 - » project needs apps support and involvement

B61 Laydown Problem
- FY00 x-cut focus app -

- **Primary purpose:** to provide focus and demonstrate core REM/PSE/DISCOM technologies on a mission critical application

- Initially focusing on the nose-cone-crush modeling problem

- Driven by the needs of the weapons designers, analysts, and application developers (B61 designers and analysts, Sierra, Presto/Pronto, ACCESS)

- Key objectives… *to significantly reduce the (wall-clock) time and complexity required to setup and run models while improving basic modeling capabilities, and to provide improved model management (rerun and archiving) capabilities.*
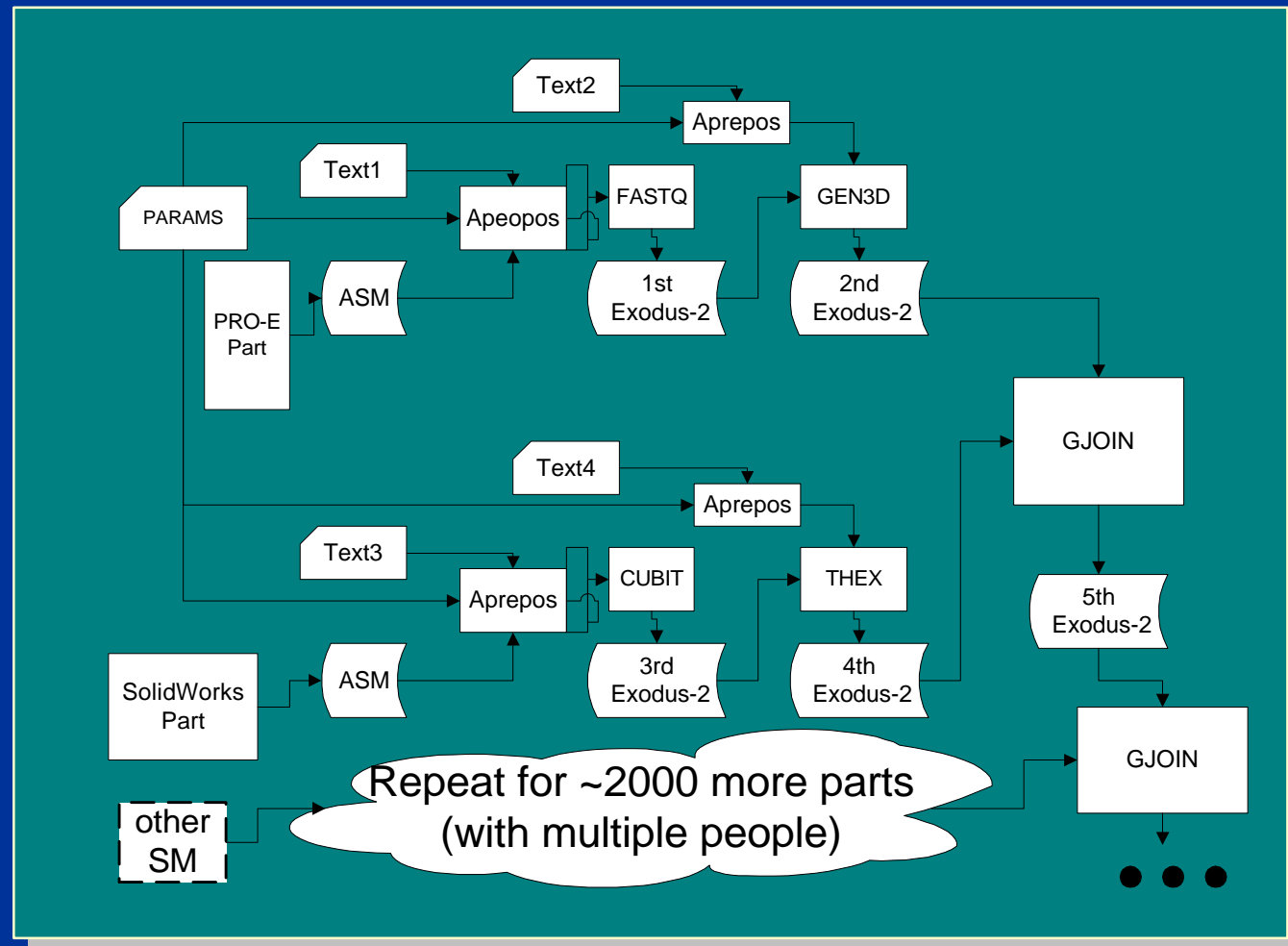
Really big picture
(integrate end-to-end modeling)
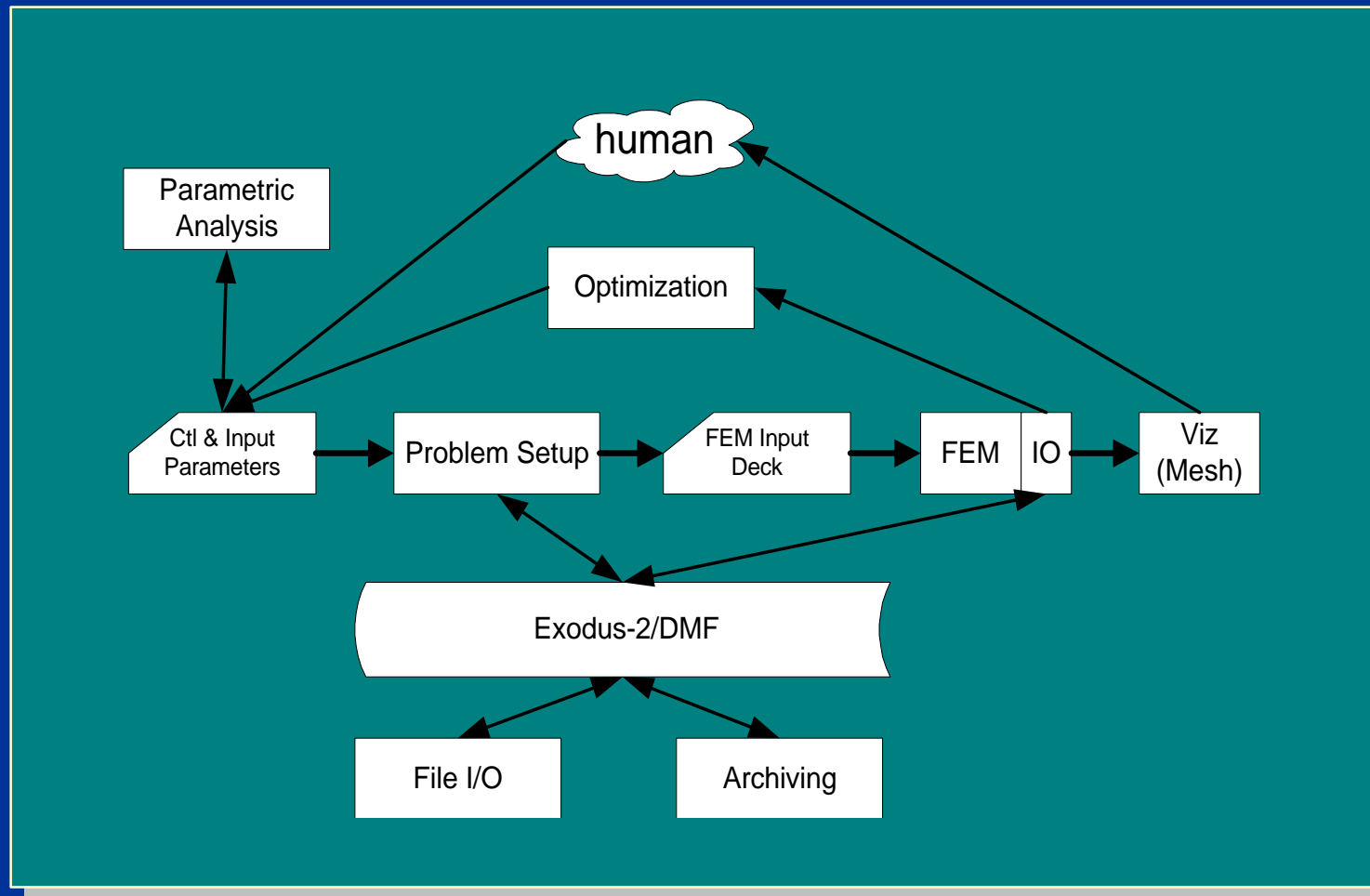
Large-scale integrated model management is a nightmare

… by hand:

Large-scale integrated data management isn't much better

Params

Text → Aprepos/ translators → Meshing → [ ] → Remeshing/ Validation/ GJOIN/ Visualization/ Partitioning

MANY FILES

FastQ
Cubit
IDEAS
Patran

GENESIS
EXODUS
EXODUS-2
DMF

GJOIN
GRepos
Gen3d
GenShell
GenHexShell
Nemslice

algebra, BLOT, Grope, mustafa, Numbers, SPHGen Verde

In a sense, the data doesn't flow, the processing does.
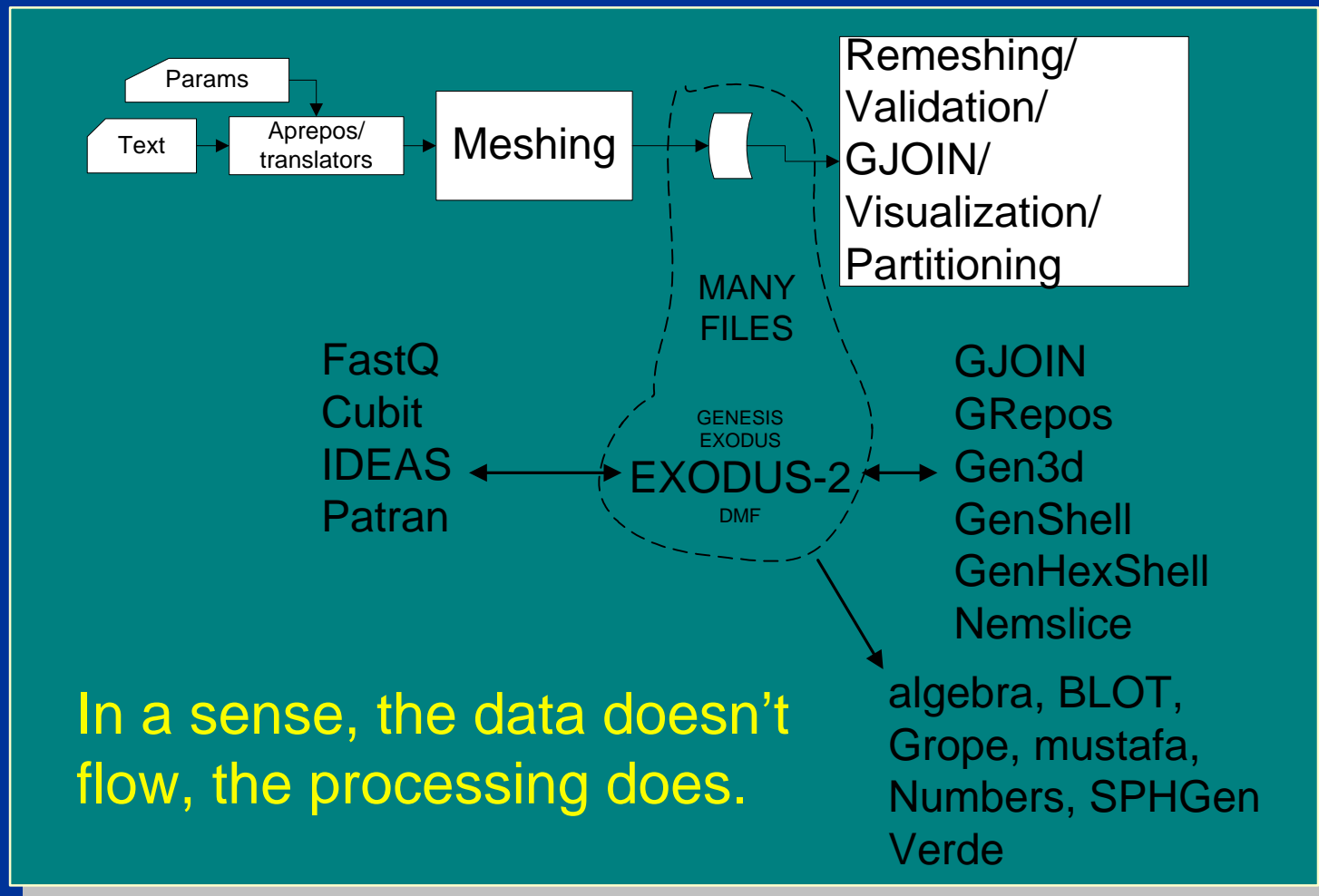
Current state of B61 laydown model setup system represents an ad hoc evolution of tools

Lee T.
Dennis F.
Steve A.

Pronto

Others

Amy G.
Greg S.

Ted B.
Ray M.
Greg S.
Tim T.
David W.

Cubit

ExodusII

GJoin

FastQ

Gen3D

Amy G.
Greg S.

Ted B.
Ray M.
Greg S.
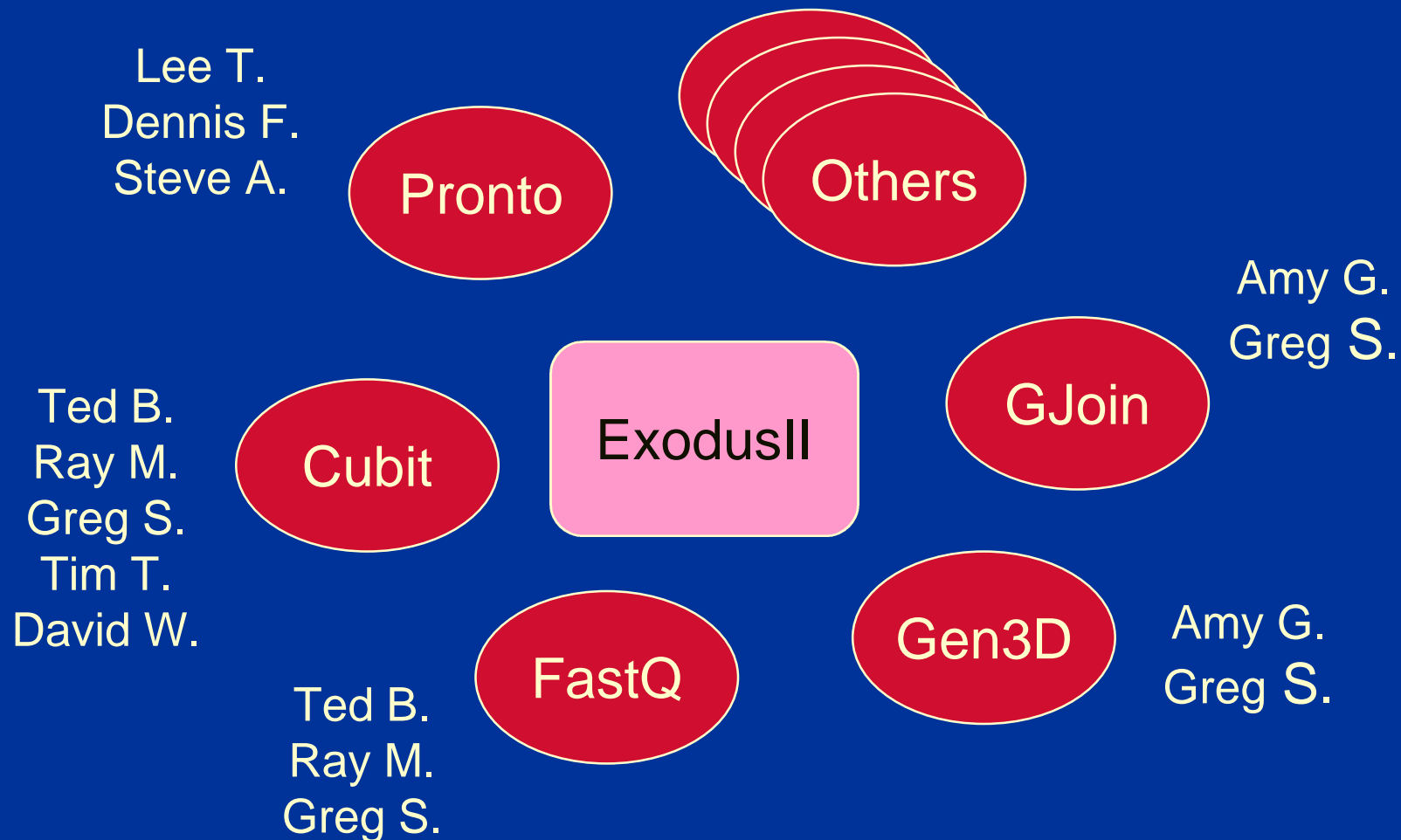
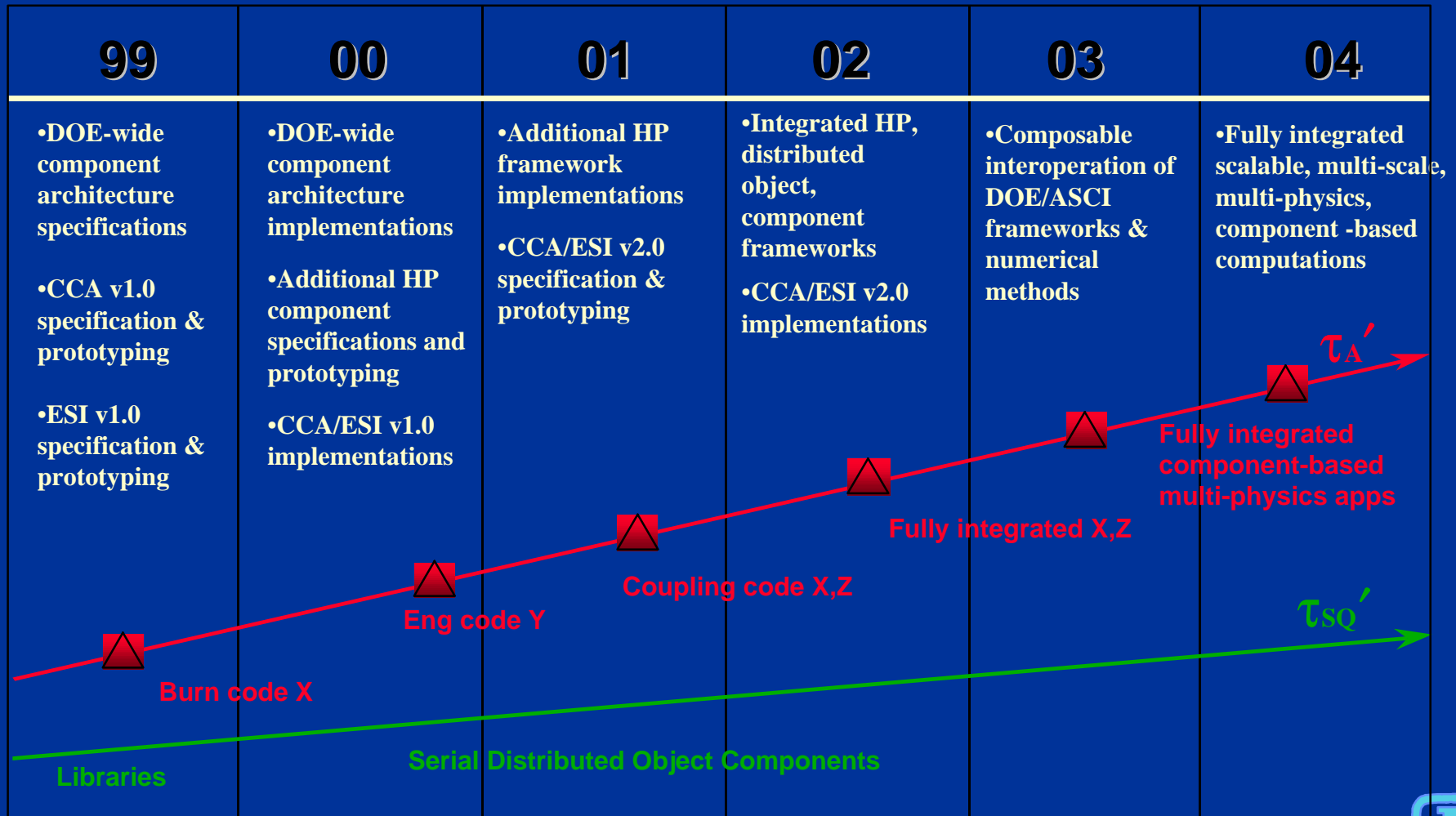# Is this problem unique to the B61 laydown modeling effort?

Absolutely not.

Essentially all SNL FE app codes and modeling efforts use a common set of tools that comprise the 'model setup system' (e.g., ACCESS).

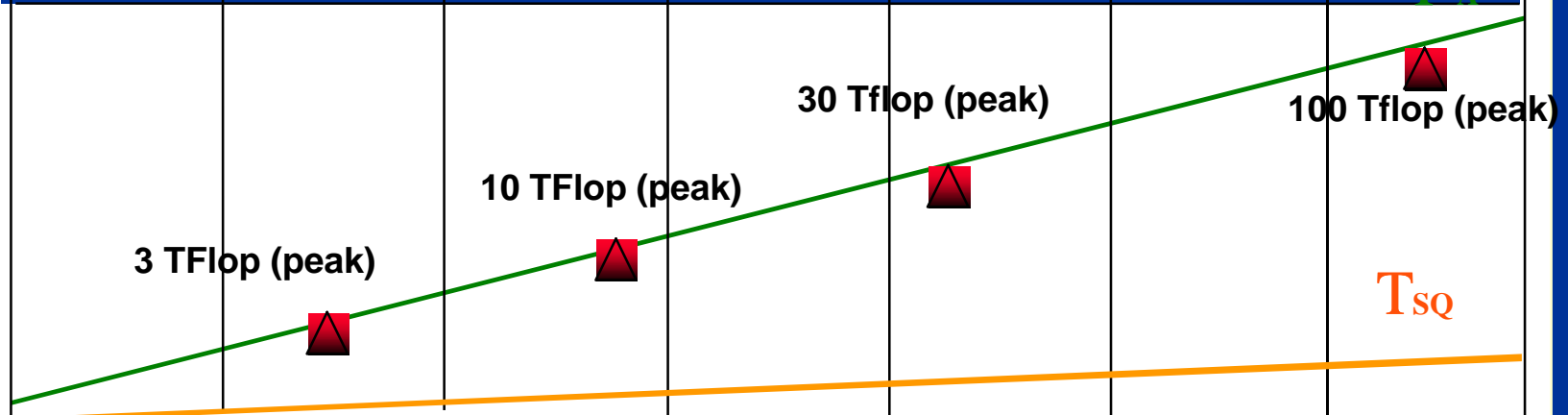# Scalable Component Architectures (ASCI SW Integration Barrier Curve)

99	00	01	02	03	04
•DOE-wide component architecture specifications •CCA v1.0 specification & prototyping •ESI v1.0 specification & prototyping	•DOE-wide component architecture implementations •Additional HP component specifications and prototyping •CCA/ESI v1.0 implementations	•Additional HP framework implementations •CCA/ESI v2.0 specification & prototyping	•Integrated HP, distributed object, component frameworks •CCA/ESI v2.0 implementations	•Composable interoperation of DOE/ASCI frameworks & numerical methods	•Fully integrated scalable, multi-scale, multi-physics, component -based computations

$\tau_A{'}$

Fully integrated component-based multi-physics apps

Fully integrated X,Z

Coupling code X,Z

Eng code Y

Burn code X

$\tau_{SQ}{'}$

Serial Distributed Object Components

Libraries

Problem Setup

98	99	00	01	02	03	04
• Serial prob. setup of 10 M UCD in 6mos **Industry improving at ~ 5% per year**	• Serial prob. setup of 10 M UCD in 3mos. • Tool for checking mesh validity	• Serial prob. setup of 10 M UCD in 1mo • Serial prob. Setup of 100M UCD in 3 mos • Parallel adaptivetet meshing	• Serial prob. setup of 10 M UCD in 2wks • Interleaved meshing and load balancing	• Serial prob. setup of 10M UCD in 1 wk. **We need a factor of 2-3 per year improvement** • Parallel multilevel meshing	• Serial prob. Setup of 10M UCD in 3 days • Automated meshing for optimization	• Serial prob. setup of 10M UCD in 1 day • Serial prob. setup of 1B UCD in 3mos.

Problem Setup

Platforms

3 TFlop (peak)

10 TFlop (peak)

30 Tflop (peak)

100 Tflop (peak)

T'_A

T_{SQ}

Solution (CS strategy)

- **CS technical strategy**
  - » develop/deploy a fully extensible component architecture
    - – integration of loosely- and tightly-coupled components
    - – draw from existing frameworks (SI/PDO, PRE, CCA, ESI, FEI, IDEAS, …) to form core architecture and services
  - » leverage commercial developments (e.g., EJB, CORBA, COM, …)
  - » address technology gaps missing from commercial sector
  - » base the components on open standards where possible
- **Focus on a particular ASCI weapons problem**
  - » top-down design and prioritization
  - » ASCI scale problems - size matters
- **Run this as a large-scale SW project**

Primary Project Elements

- Integrated model development and management system
  - » Model Manager
    - – provide integrated environment for D-to-A tools and info
    - – simplify process by better, integrated tools
    - – improve info content and repeatability for modeling runs
    - – improve 'rerun' capability for design and model refinement
    - – objective is to drive wall-clock time down and reliability up
  - » "In-core" DMF (persistent object)
  - » Integrated meshing tools
    - – mesh joining and validation (w/ vis)
    - – improve selected tools as well as overall integration (e.g., Gjoin++)
    - – standards-based development:
      - data standards (e.g., DMF, solid model representations)
      - component-based

Primary Project Elements

- **Component-base system architecture**
  - » fully extensible
  - » leverage existing tools (e.g., PRE, SI/PDO, ACCESS,…)
  - » serves as backbone for integrating tools and servics
  - » addresses both loosely-coupled and high-performance domains

- **Numerical services components:**
  - » continued advances to FEI and ESI (solver services)
    - – spec and implementation advances
    - – include and augment existing methods base
    - – eigen solver / direct solver / multi-level solver extensions
    - – combine collective DOE capabilities for modelers
  - » general constraint handler component ("constraint central" - Lee Taylor)
    - – unified interface for (FEM) constraint handling
    - – BC / MPC / contact constraints
    - – hierarchical prioritization (BC <- MPC <- CC)
    - – number of constraints ~millions (i.e., ASCI scale)

Primary Project Elements

- Visualization components
  - » "standard" ASCI mesh viewing tools
  - » "standard" ASCI FE results (e.g., isosurfaces) viewing tools
  - » DMF-based interface to mesh data

- Desktop interface to services
  - » web-based access
  - » leverage SNL common engineering environment tools

X-cut Staff

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x-cut FY00 Budget Summary

- Core architecture & framework services   4.0   FTE
- Front-end service presentation   1.0
- Model Manager   4.0
- Integrated meshing components   5.5
- Numerical components   2.25
- Data service components   1.0
- Viz service/component support   2.0
- Planning/mngmt/integration   1.0
- FTE Summary ……………………………………………………………….   20.75 FTE
- $250k/FTE ………………………………………………………………….   5.2 M$
- DC ……………………………………………………………………………….   0.1 M$
- Total (PSE & DISCOM)…………………………………………….   5.3 M$

Architecutre (4 FTE)

- Rob Armstrong   1.0
- Ly Sauer   1.0
- Bob Whiteside   0.5
- Vic Holmes   1.0
- Robert Clay   0.5

                       4.0

Model Manager (4 FTE)

●	Ben Allen	0.5
●	Ruthe Vandewart	1.0
●	Rob Leland*	0.5
●	tbn	2.0

		4.0

Integrated Meshing Tools (5.5 FTE)

- Noel Nachtigal   0.5
- NCSA   1.5
- Rob Leland*   1.0
- Gary Templet   0.5
- Don Funkhouser   1.0
- tbn   1.0

5.5

Numerical Frameworks (2.25 FTE)

- Alan Williams   1.0
- Ben Allan   0.5
- Noel Nachtigal   0.5
- tbn   0.25

                    2.25

Data Services (1 FTE)

- Philip Kegelmeyer*

1.0

1.0

Front-end Services (1 FTE)

- Dave Miller   0.5
- tbn   0.5

                      1.0

Vis (2 FTE)

- John Linerbarger   1.0
- Dino Pavlakos*   1.0

   2.0

Management and Integration (1 FTE)

- Robert Clay   0.5
- Jim Ang   0.5

                                             1.0

Current status

- **PSE/DISCOM IP submitted**
  - » written as joint program project plan
  - » detailed project plan due by 10/1/99
- **B61/Presto/Sierra functional requirements definition in progress**
  - » primary areas identified
  - » detailed requirements definition in progress
  - » model manager spec being drafted
  - » Gjoin++ spec in progress
  - » DMF spec in progress (just starting)
  - » Mesh visualization requirements definition in progress

Tools are being improved and turned into components and services
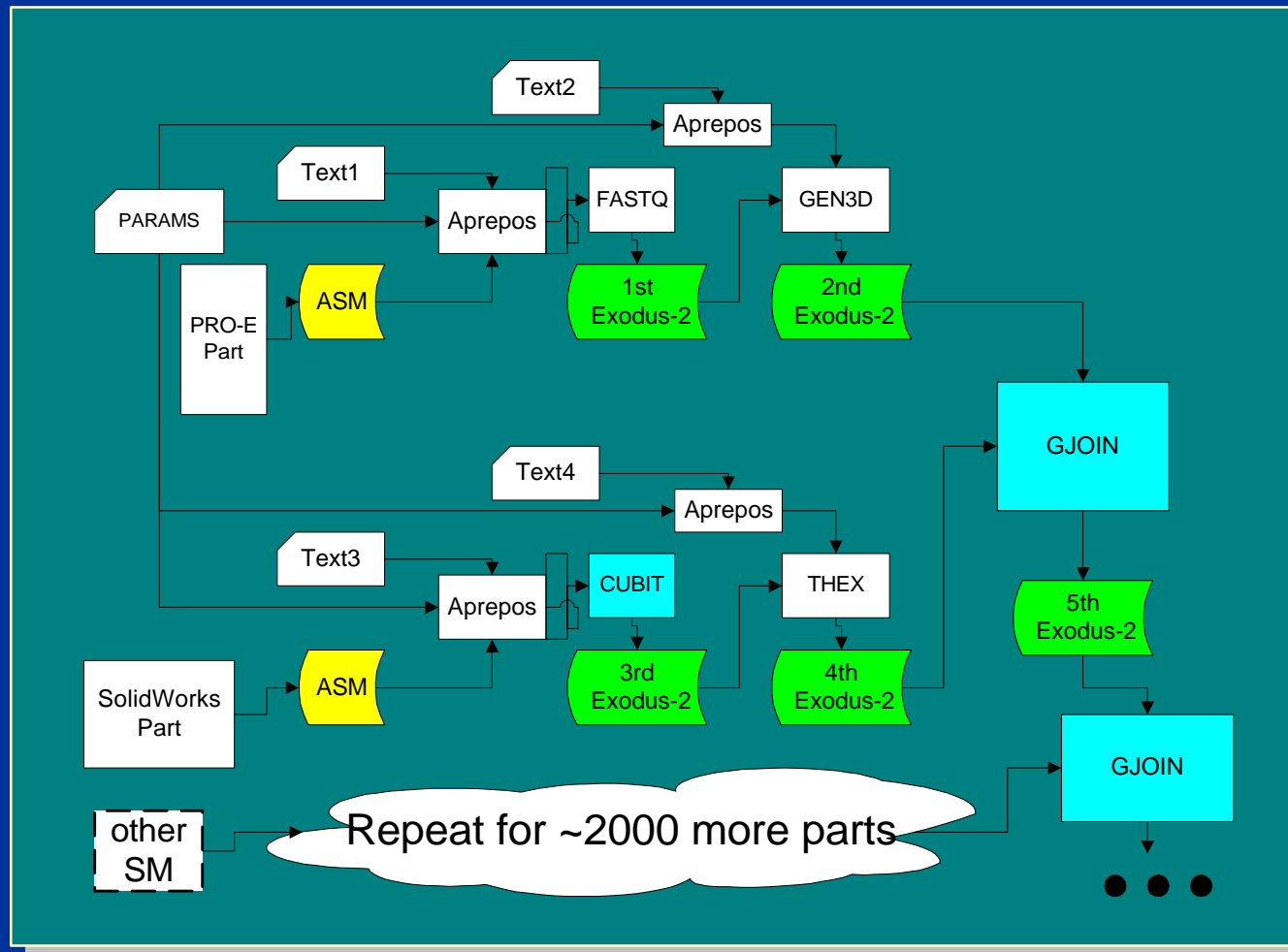
What's next?

- **Complete integrated plan for x-cut project**
  - » due by 10/1/99
  - » synchronize with B61 requirements
- **Software Integration Architecture specification**
  - » draft due 8/99
  - » proposal due 11/99
- **Integrated "problem setup" design spec**
  - » define functional requirements
  - » design system
  - » define path to build system
    - – long term design needed
    - – short term development critical - what can we do in 6-12 months to be help Charlie, Greg, Lee, and co.?

end